

APPENDIX G

Forest Stand Delineation

Steps for Assessment

Tree survey

Sampling methods

Tree canopy cover assessment methods

Forest Stand Delineation procedures

1. Old-field succession assessment
2. Tree canopy cover credit for single-family and duplex uses
3. Tree canopy cover assessment of development impact area in conjunction with Sustainable Development Incentives (Review Appendix F)
4. Tree canopy cover assessment on properties five acres or larger with institutional and community service uses or recreation uses
5. Forest analysis for baseline documentation to create a conservation easement
6. Tree canopy cover assessment where trees are removed without authorization (10.137)

The forest stand delineation is a form of site assessment prescribed for its function to evaluate for tree species size, distribution, location, and age and may be used to

identify tree canopy coverage for the purposes of tree mitigation calculations. A forest canopy goal is typically sought instead of mandating a forest canopy requirement.

Ordinance:

(22) FOREST STAND DELINEATION ("FSD") means a comprehensive assessment of the conditions of a property using multiple types of information, including, but not limited to, a tree survey, aerial imagery collected from private or public sources, natural resources assessments, topographic maps, management plans, a map of conservation areas, land use maps, etc., to provide the required data to determine tree replacement requirements and forest conservation objectives.

(B) A forest stand delineation ("FSD") used for the purpose of calculating the total square footage of forest canopy coverage of building sites and providing an ecological assessment of a property.

A FSD must be approved by the building official.

The building official shall determine the information required to be provided in an FSD.

The City of Dallas has determined that the conservation of woods and forests also involves the demand for removal of vegetation to make way for city development. The FSD provides a means for reducing costs and burden for tree survey assessments while also incentivizing the protection of more sensitive and critical woodland areas needed for water conservation and wildlife habitat. The tree survey assessment with a forest stand delineation may be an option for a large site with varied and large tree stands, or relatively small stands of a single species or mix of Class 3 trees.

Steps for assessment

- Contact the city arborist with questions. The arborist will work with the surveyor/assessor to help determine the best strategy for conducting the field assessment. The review will include the following procedures:
- Conduct a pre-tree survey assessment to define tree stand types and areas on the property. This will be a process of aerial imagery and field analysis of the site.
- Attain historical aerial imagery of the property for up to the past 60 years. This data can be found through private and public sources and available for purchase. The images can be read from the computer and compared with other dates. Historicaerials.com is a good private source of data for the Dallas area as well as Google Earth and Maps.

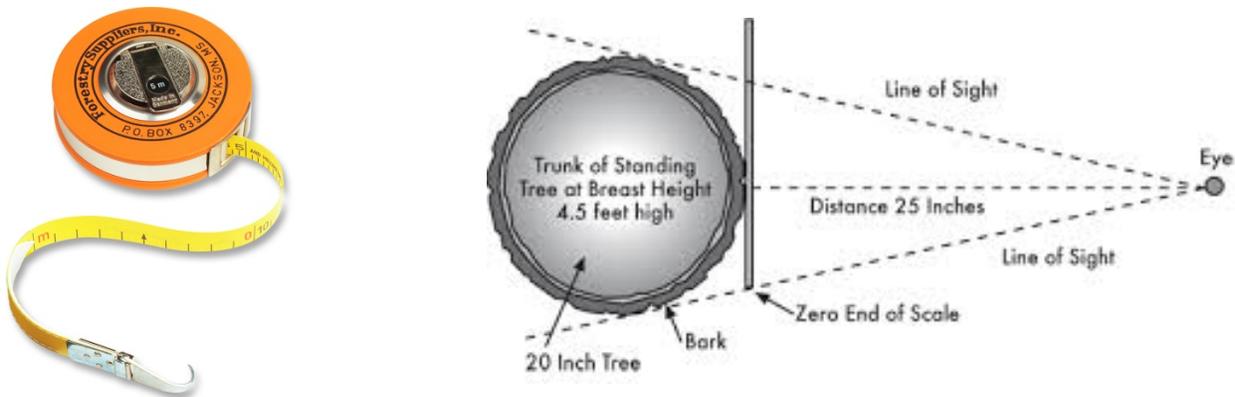
- Determine areas of stratified subpopulations by their general classification (1, 2, and 3) where applicable. Full tree specification will be required for significant trees, primary natural areas, and general mature Class 2 conditions.

Tree Survey

The primary method of tree mitigation calculations is the tree survey. Through this process, a tree diameter measurement is taken on every tree on the property and the species, location, and condition (if available) is provided. The sum of all classified individual trees is calculated to determine the potential tree replacement requirement. Refer to Section 51A-10.135 for how to measure the diameter of a tree.

Multiple tools can be used in measuring a tree such as a Biltmore stick or diameter tape. Both items are available at forestry supply stores. When the calibrated tape is not available, a standard inch-measure tape can be used to size up the circumference of the tree. Then use the Pi-value to calculate the diameter of the tree. The classified number for mitigation can be calculated with knowledge of the tree species. If the tree condition is not suitable for mitigation, identify the tree with a proper rating to delist it.

The tree survey is verified by the city arborist to confirm the survey was completed as accurately as possible and that trees were not missed or done incorrectly.



1. *The diameter tape is heavy duty and calibrated to measure the diameter outside of bark for the tree. The Biltmore stick uses its calibrated marks with your line of sight to indicate the diameter measurement of the tree.*

Tree Sampling Methods

Sampling is a process to allow for a reduction of time and effort in completing a full 100% tree survey and to account for a generalization of potential tree mitigation. A fixed plot sampling method for 1/5 or 1/10 of an acre may be conducted in the Mixed species upland area to determine general species and to provide a tree size determination.

It is presumed there is a potential for error in the final field calculations, but the building official will evaluate the sample methods, precision, and analysis of the historical imagery, to determine a history and succession level of the single or numerous tree stands on the property. The level of accuracy demanded will depend heavily on the purpose of the forest stand delineation and the extent of the future development area on the property. A conservation easement study may be less exhaustive than an old-field succession assessment.

Fixed Point Plots (transect line sampling)

Apply fixed point plots in the defined area in which to sample the number and species of trees, and the diameter of the trunk, and the canopy.

Determine:

Trees per acre – species and size (diameter inches) of protected tree is recorded for each plot.

Measure canopy area by the square feet of protected trees in the plot area (if applicable).

Develop a stand table from:

Average number of protected trees/species

Average number of protected inches

Average tree canopy diameter (as needed)

Suggested forms of survey in the ordinance:

Quadrat plots – Framed sample area to isolate a location to measure biodiversity and the distribution and population of a plant species.

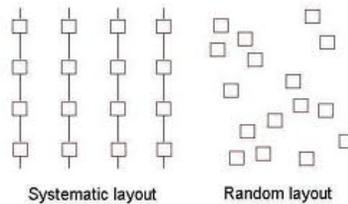
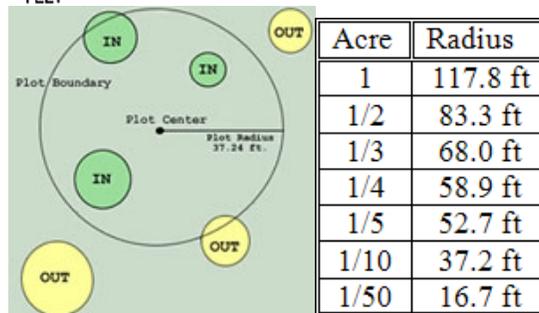
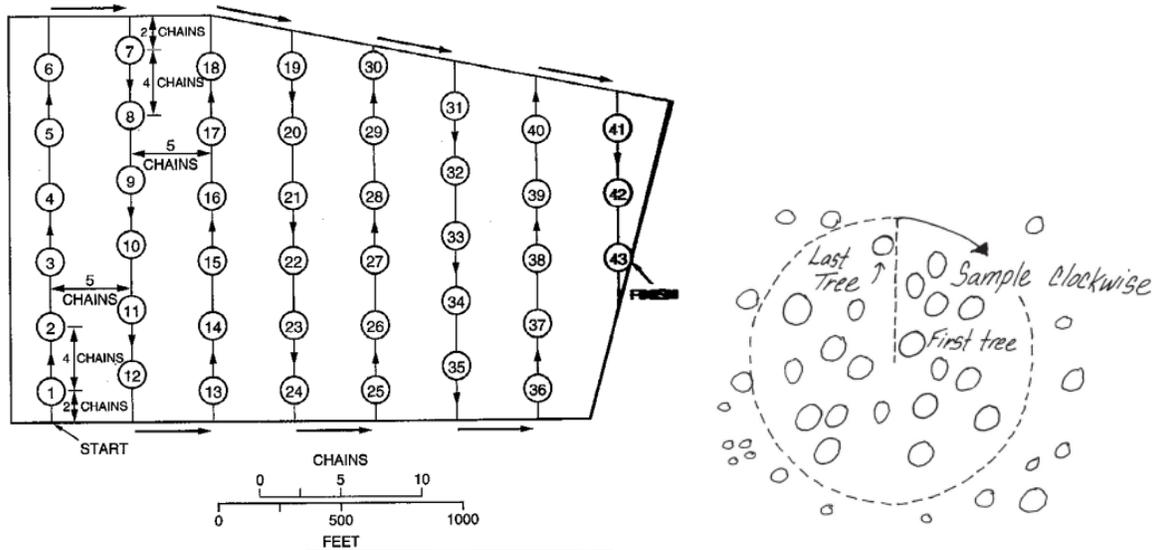
Transect line sampling – A line is marked at regular intervals and the population of plants are measured for species, size, density and canopy.

Point-quarter sampling – Measurements for Relative Density, Relative Frequency, and Relative Basal Area are determined to figure the stand's Relative Importance Value. It helps establish the relative dominance of a particular species in the stand.

<https://www.jove.com/science-education/10060/tree-survey-point-centered-quarter-sampling-method>

The method of sampling is best determined by understanding the land and vegetation types being measured. Consult with the city arborist for discussions on the methods.

Diagrammatic plan for a 10 percent systematic line-plot cruise utilizing 1/5-acre circular sampling units.



2. Examples of fixed point sampling using a transect line or shown in random layout. One chain = 66 feet.

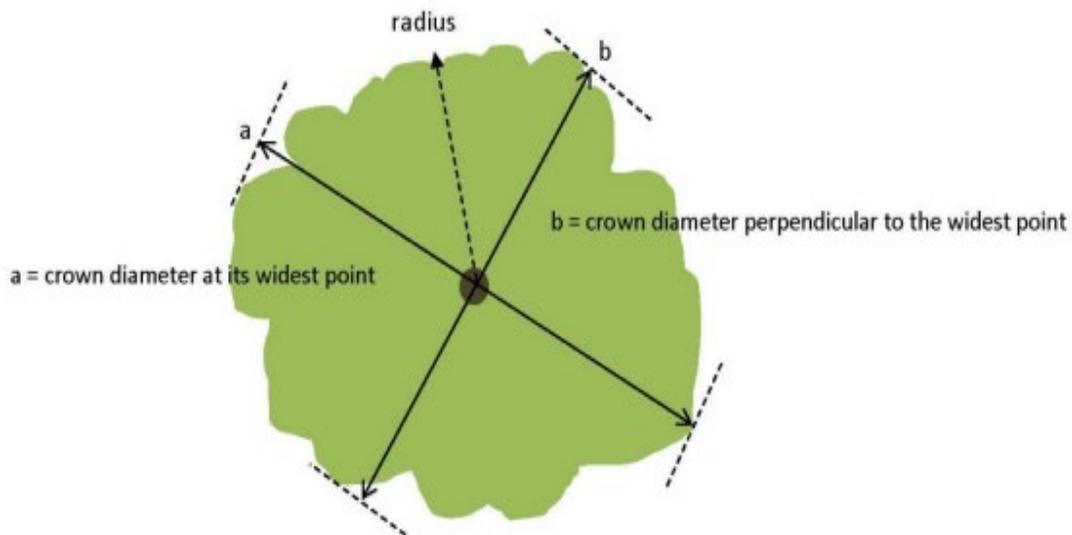
Tree Canopy Cover Assessment Methods

Measuring for tree canopy is to define the extent of the horizontal distance of the crown of the individual tree, or a group of trees, in order to calculate the square footage of that area on the property. Since a tree or its canopy is typically not actually fully round, and since they are continually growing or decreasing, you are taking an estimation that will give you the best reasoned calculation available.

Any canopy measurement should include the ground-up assessment for the most precise and accurate measure. By this we mean to be on the site with another person to assist in making distance measurements around the tree. It is also important for helping to identify the tree being measured.

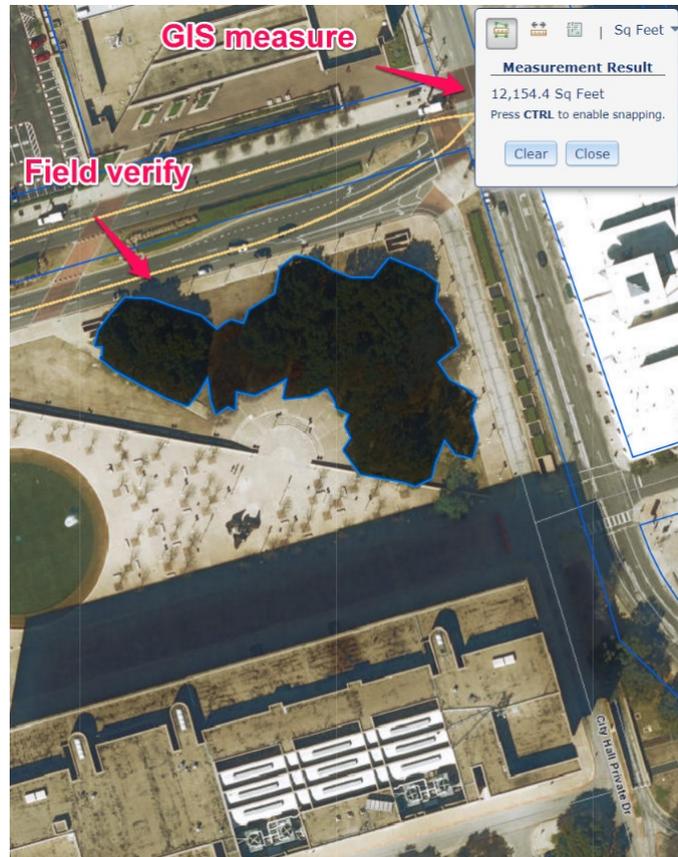
The top-down method with aerial imagery is good for getting a general assessment of the coverage, but it should not stand alone as your only reference. It is also possible that an incomplete assessment of the site may indicate errors by picking up shadows in your area measurement or not identifying the tree.

Measuring tree canopy coverage



3. Add those two diameters together, divide by 2 to get the average diameter.
4. Divide the average diameter by 2 to get the average radius.
5. Square the radius (r) and multiply by π (a constant of 3.14) to get the canopy cover in square feet.

3. [Measuring tree canopy coverage - City of Decatur, GA](#)



4 *The City GIS, or other satellite images, have area measurement tools to provide a general area calculation.*

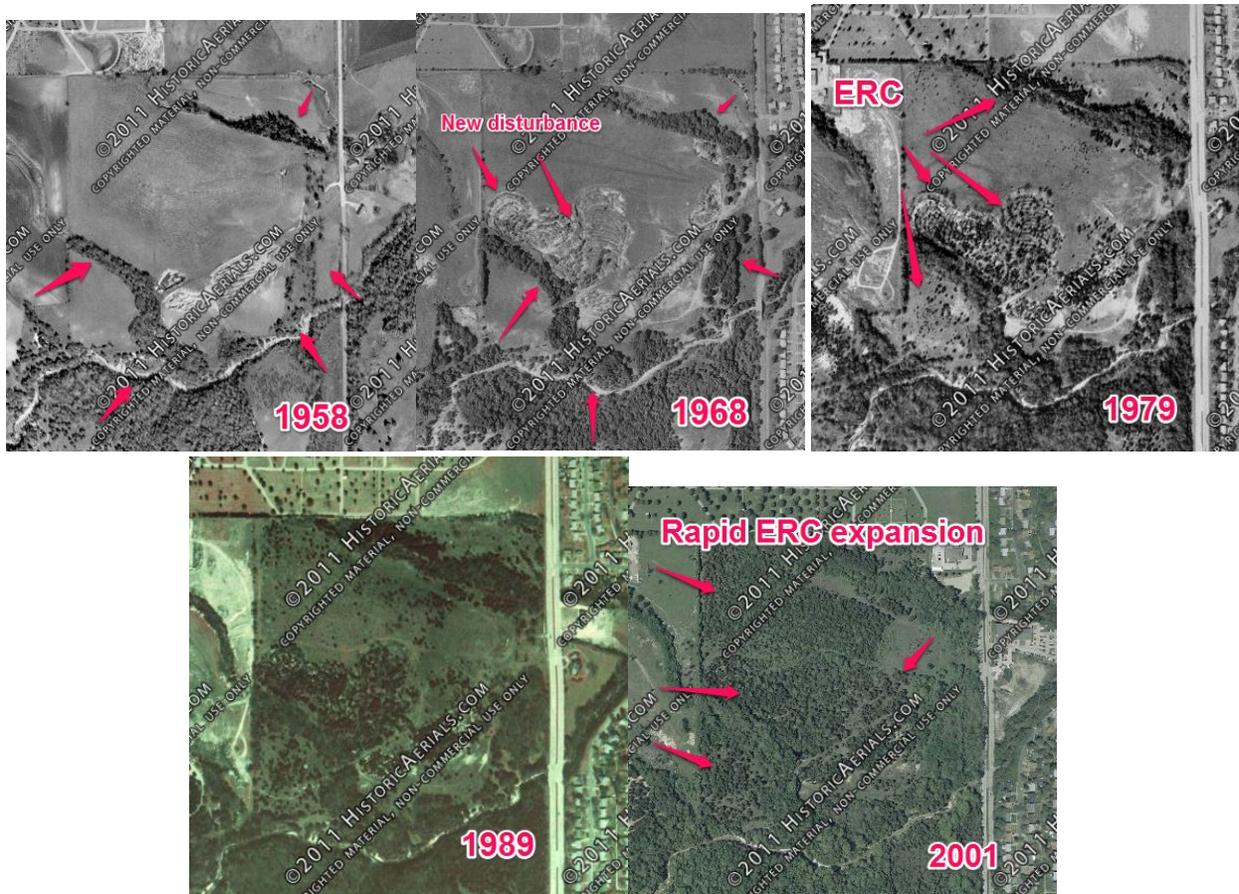
The aerial image and measuring tools are also very helpful and efficient in getting a general number quickly. The City of Dallas GIS site has the ability to use recent aerial maps and to define distances and area measurements. Once this measurement is completed, you can verify the boundaries of the alignment and then revise if necessary.

Google Earth and **Google Maps** both offer some unique additional tools such as historical imagery (dating to about 1995) and street view images (Maps offers past images) which can help provide quick information for locations near recorded locations.

Forest Stand Delineation Procedures

'The FSD is an inventory of forest cover and other environmental features on site. Through resource mapping and written description, this process determines the most desirable areas for forest conservation. Forest characteristics that are usually

documented include forest stands, canopy closure, dominant species, size class, and number of trees per acre.' - *A Citizen's Guide to the Forest Conservation Act in Maryland.*



5. Sites like Historic Aerials can provide information about activities on a property over decades of time to help define stand boundaries and quarry sites. This process is a required and important early step in the old field succession assessment.

The Forest Stand Delineation has multiple purposes beyond looking at old-field succession assessments. However, it may be its most beneficial application. Essentially, it is merely the tree survey PLUS all other potential tools suited for a field assessment for biology, geology, botany, or any range of studies suited for the purpose. The city arborist will assist you with determining what is needed for regulation, but the end product could be suited to simply understanding the property for its future function.

The FSD will not be exact in its results, but it will favor conservative results for mitigation for the individual tree for regulatory purposes. The process is not intended to produce a value on the land for environmental assessment or its natural functions. That is a task reserved for our society.

“Examine each question in terms of what is ethically and aesthetically right, as well as what is economically expedient. A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.” - Aldo Leopold

10.132(b)(4)(B): *The FSD is applicable to and may be used to calculate:*

1. OLD-FIELD SUCCESSION ASSESSMENT

(i) Tree canopy cover assessment for old-field tree stands and undeveloped lots, two acres or larger, in early succession stages when:

(aa) a stand, or partial stand, with a minimum of **60 percent Class 3, eastern red cedar, or unprotected trees** is located in a proposed development impact area;

(bb) the forest stand delineation excludes areas within 50 feet of a 100-year floodplain, 50 feet of a wetland, 50 feet of an escarpment zone, or 150 feet of a stream bank;

(cc) the trees in the stand, or partial stand, is designated in an **age class of 60 years or less** by the building official based on site and historical data; and

(dd) the stand is assessed and surveyed using tree sampling methods which provide general species quantity and tree size determinations based on the use of quadrat plots, a transect line sampling method, point-quarter sampling method, or other method approved by the building official.

10.134:

(6) Forest stand delineation exceptions for old-field and undeveloped lots. When an FSD, under Section 51A-10.132(b)(4)(B) is used to assess tree canopy coverage:

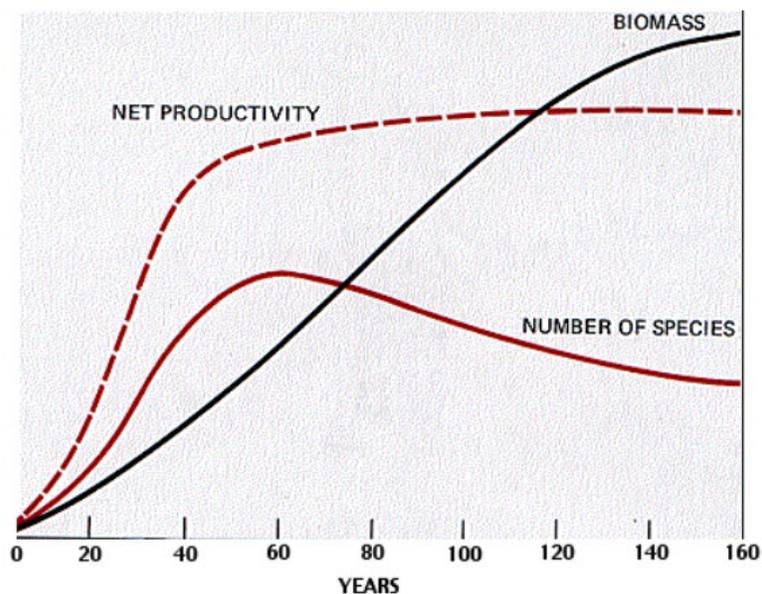
(A) except as provided in this paragraph, no mitigation is required for a tree stand when:

(i) at least **60 percent of the trees in the stand are Class 3, eastern red cedar, or unprotected species**; and

(ii) **the average tree diameters in the stand are less than 12 inches DBH.**

(B) significant trees in a stand located on an old-field or undeveloped lots must be mitigated.

The old-field succession assessment is a primary function of the forest stand delineation. It allows for a more general assessment of stands of trees which are of a relatively young age class and has a monoculture (a single species) or a mix of early succession brush and small trees, or invasive shrubs and trees. Areas of the property can be randomly sampled and the species stratified (separated) and assessed distinct from sloped and older wooded sections and away from the heavily wooded creeks and streams.



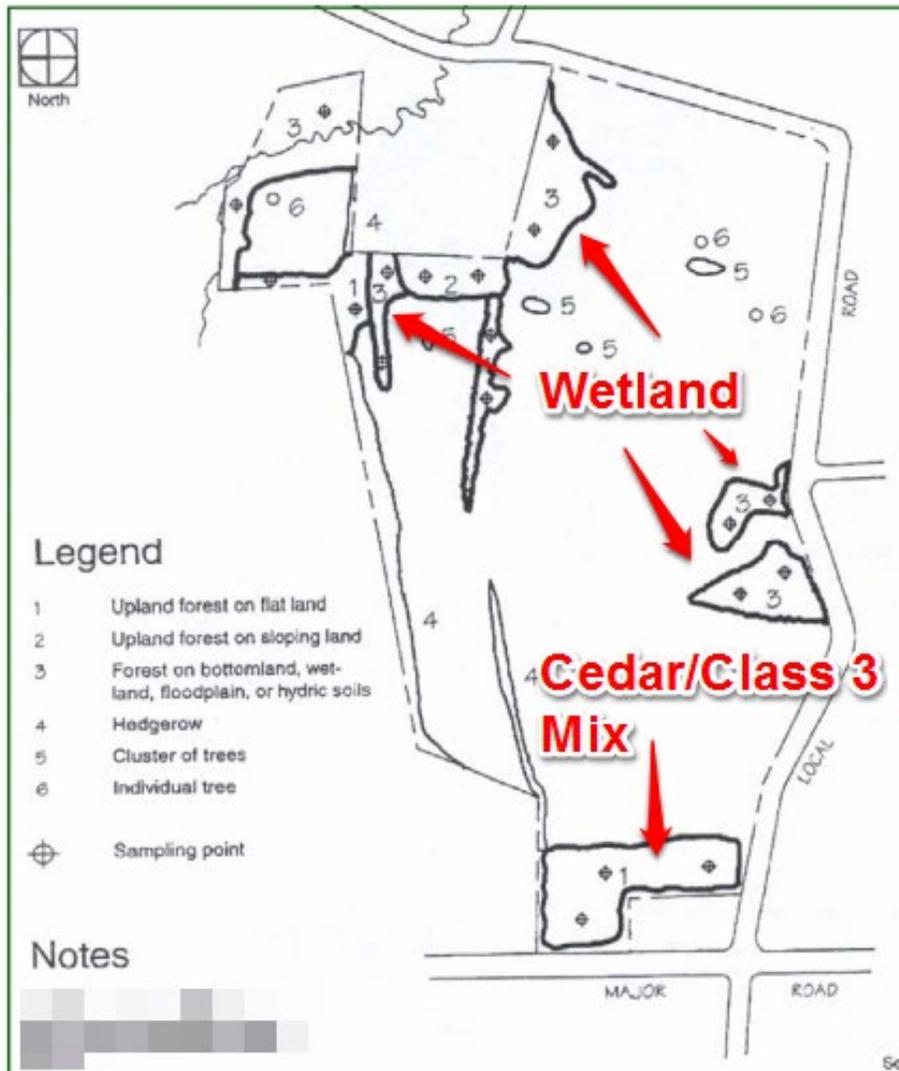
6. *Plant Succession in a temperate deciduous forest. Whitaker, R.H., Communities and Ecosystems, Macmillan, 1970.*

Plant succession as a result of man-made interferences in the changes to the land is secondary plant succession. When a dominant plant has been removed, the new stage for succession begins. This process occurred over the last 150 years in all regions

of Dallas through clearing for farming, ranching, mining and all of the other various uses and have regenerated after the properties were left unmanaged. Naturally, these areas have grown up with large amounts of vegetation of various species. In some locations, the soils are depleted from extensive use and new growth is slow to take hold. In others, the biomass production is exceedingly high and is filled with many plants of many species.

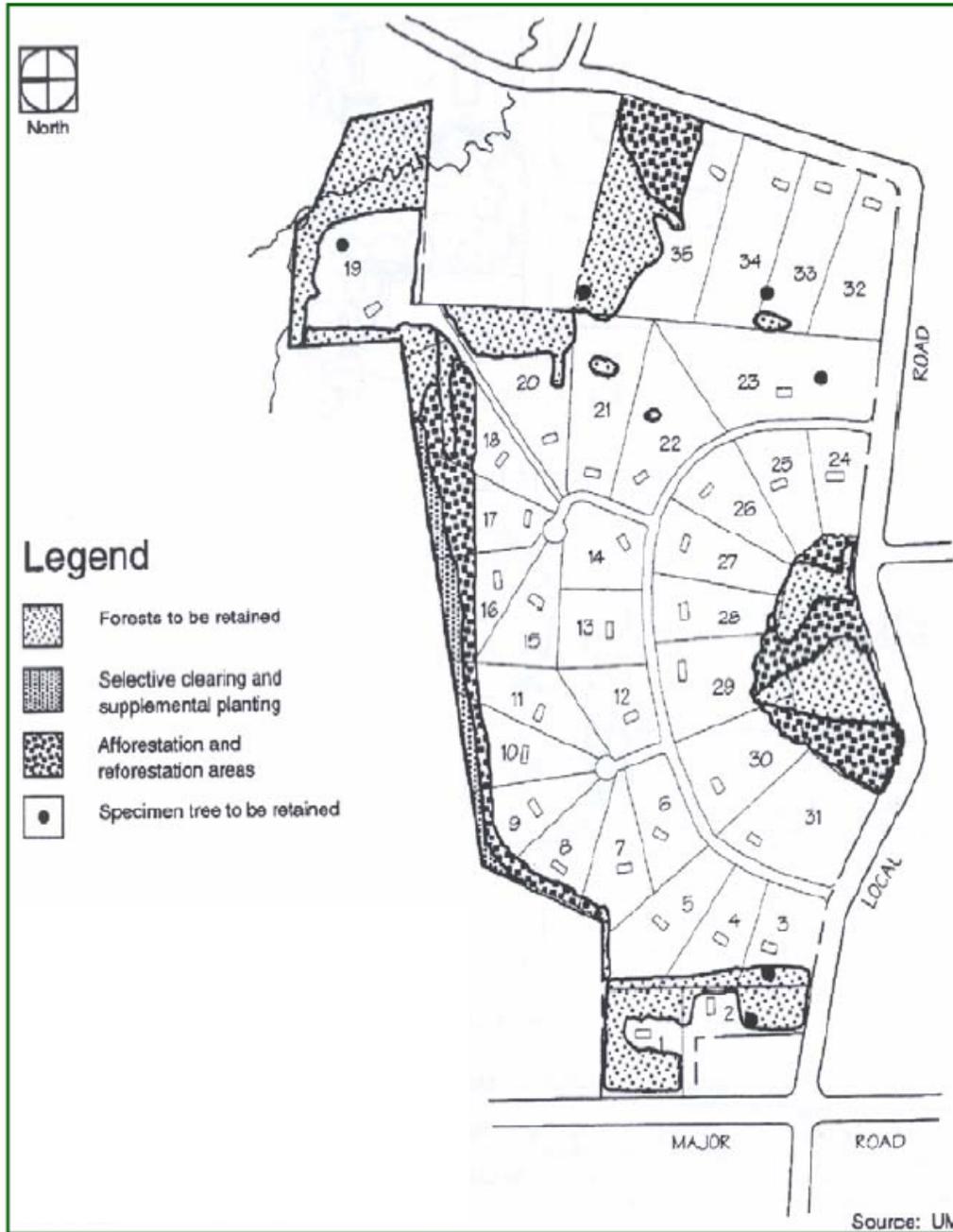
Over time, the net productivity of the site increases and the diversity in the plant community increases for a time. When the system approaches the climax, the rate of increase diminishes and the system eventually levels out by achieving peak efficiency.

The Old-Field Succession Assessment measures the plants in the earlier stages of this succession relative to the measure to determine only its mitigation value based on the rates listed in the ordinance. It does not assess the quality of the site for its functions of wildlife habitat, stormwater retentions, or other valuable environmental functions the property provides for the community.



7. *The tree stands can be separated by initial analysis in the field combined with aerial imagery.*

When we look at the old-field succession assessment, we can use aerial imagery to help identify the age, species, and locations of tree types and densities in a particular area. We are also aided by topographic maps, street view images, or other similar data to give a history of the site. On a map, these areas can be distinguished from the surrounding vegetation and open spaces and analyzed individually.



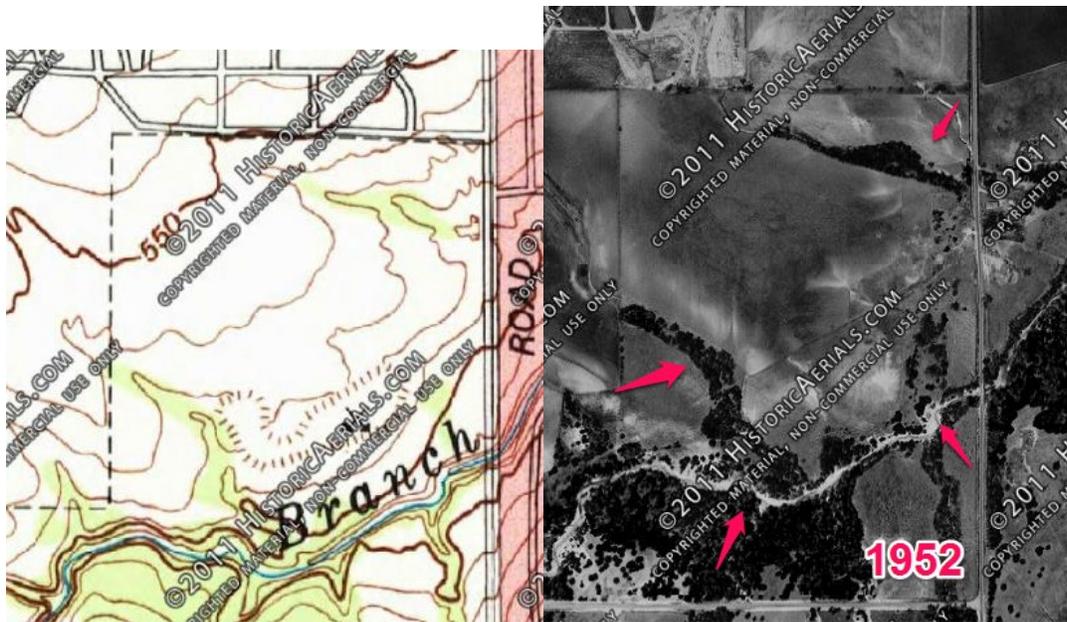
Source: Maryland State Forest Conservation Technical Manual

8. The owner can make decisions to design with land contours and the natural vegetation retained to buffer the community.

The land owner can then make decisions to alter development designs to retain and conserve wooded areas by also making best use of the natural drainage patterns. The

general process begins with recognizing what is of intrinsic value to the city and the property. These general rules must be applied in analyzing the property:

- The Old-Field Succession Assessment is applicable to tree stands on undeveloped properties 2 acres or larger. .
- The FSD must be completed prior to any disturbance resulting in the removal of trees on the property. **The assessment determines only the areas to deduct for free mitigation by age class and dominant species, but it does not give authorization for the clearance protected trees by clearing or grading.** A site with no protected trees requires only a clearance authorization from the building official.
- The chief arborist must agree with the district arborist and the natural resource assessor on the outcome of the forest stand delineation.
- A tree removal application must be issued for the protected tree removal to occur in the old-field succession area. If no protected trees are identified in the area, then an authorization for clearing is required from the city arborist.
- Class 3 trees are identified in the definitions of Article X included in this manual.



9. *Using the topographic maps and older images will give a good look at the historical uses of the property. This information will help guide the site assessor on where the biomass has been generated on site and for how long.*

Analysis

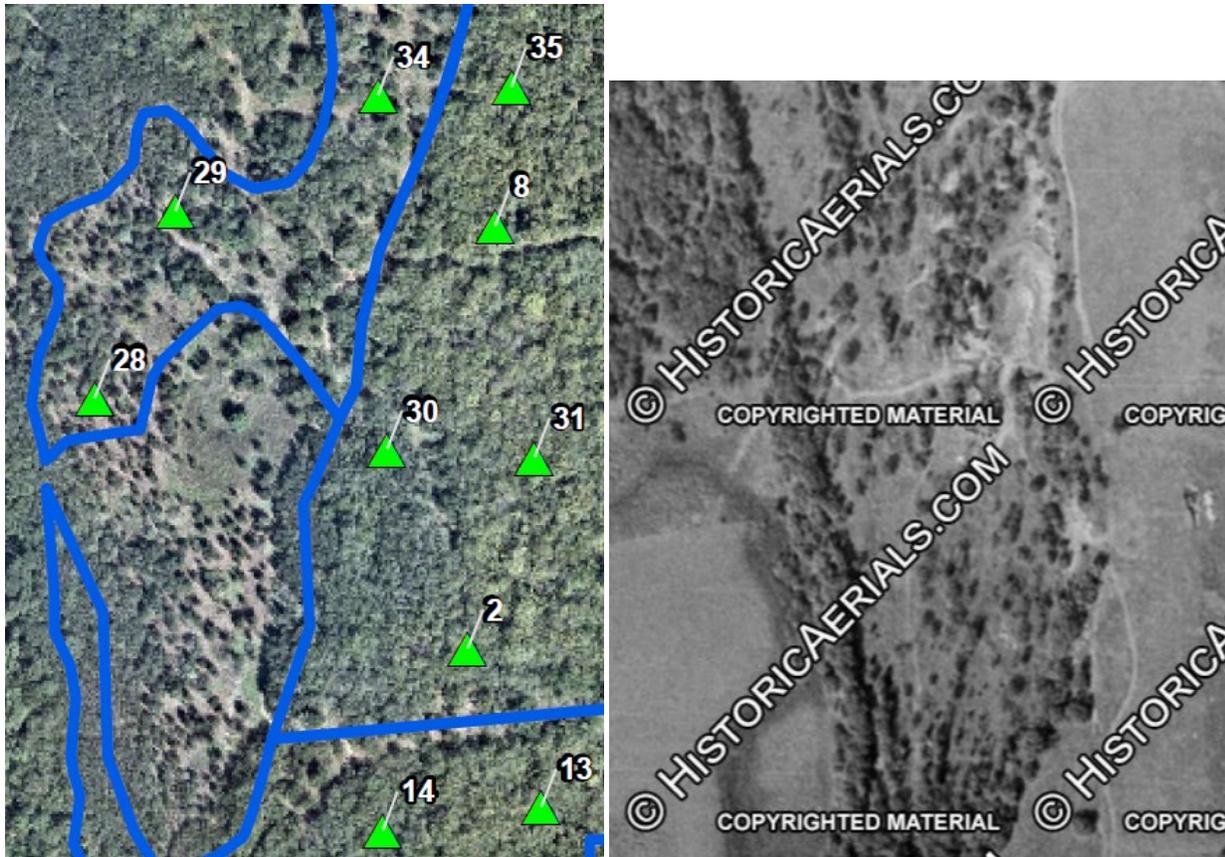
A field result can be interpreted in various ways, depending on the complexity of researching the age, species diversity, and location of the vegetation. When identifying the classification of trees, and the additional mix of invasive plants that may congest the site, the effort becomes more intensive and time consuming. It is possible that more than one entry will be needed into the property to identify the lines of stratification needed to define the old-field qualified area from the unqualified area. The density of composition of the vegetation in the woodland area will determine the difficulty level.

In an old-field succession assessment, there are specific criteria that determines the qualification of the stand:

Classification of the tree and the stand

- A tree must be in a stand, or partial stand, of Class 3 trees, as defined in Article X, or eastern redcedar, for a minimum of 60 percent of the stand in the proposed development impact area.
- A location must be a qualified area not within 50 feet of a 100-year floodplain, 50 feet of a wetland, 50 feet of an escarpment zone, or 150 feet of a streambank.
- The trees in a stand, or partial stand, must be in an area of an Age Class of no more than 60 years, as verified by the building official based on presented site and historical data.
- The average diameter of all trees in the stand is less than 12-inches.





10. A species-diverse site with mixed density and 100-year floodplain can create complications in determining survey points if placed randomly. A fixed point method will provide more precise record of plant distribution. The site assessment shows 10 plots in separate stand types. The old photo is the same location in 1979 after mining disturbance. Fields on the east and west grew mostly to mesquite, hackberry, elm and Osage-orange. Most of the tree samples in those areas identify a majority less than 12-inches diameter.

Class 3 trees: (40% mitigation)

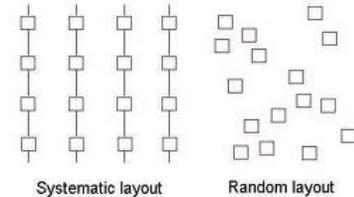
Arizona ash, black willow, cottonwood, hackberry, honeylocust, mesquite, mimosa, mulberry, ornamentals, pinus spp., Siberian elm, silver maple, sugarberry, or a small tree.

Process:

1. A fixed-point plot would provide more information to differentiate species in a dense location if provided with enough sample points. Alternatively, a series of quadrat plots in select areas after the initial sampling may provide suitable

data to split the stand to their subgroups. Discuss options for sampling with the city arborist before proceeding if you are not certain of the methods.

2. Verify the estimated age class (or classes) of trees on the property. Back up your data research with field observations.
3. Determine the form of field measurement and percentage of sample area to be used and seek recommendation from the city arborist on the process.
4. Establish each point within the qualified area on the property through either the systematic or random layout.
5. Proceed with the field measurements.
Document your observations as you can.
Account for tree conditions and surrounding species of plants.
6. In each point, determine the number of Class 3/ERC trees in the sample and differentiate from all Class 2 trees. **If over 60% Class 3/ERC, proceed to next step.**
7. In each point, determine the average diameter of all trees in the sample. **If less than 12-inches in diameter, then proceed to the next step.**
8. Analyze the species composition and tree sizes and confirm if each plot qualifies for the old-field assessment. If the trees are majority Class 2, or the plot population average is 12-inches or more, the plot does not qualify. Determine a line of separation of two adjacent plot points by conducting additional field assessment and data study as needed. Provide a reasonable justification for the demarcation line of the distinct stands and provide the results to the city arborist.
9. Work with the city arborist until a conclusion is given to distinguish between the qualified old-field succession assessment area from areas which will require additional tree survey assessment, if the area is to be within the development impact area of a future project.
10. Vegetation removal will be determined by the building official based on the amount of land area and tree protection status as well as the timing of permit or contracts to commence a project. Clearing authorization will be allowed for unprotected trees only. A tree removal application is required for the removal of any protected tree in the old-field area. If the area of clearing can clearly distinguish between a qualified stand and an unqualified stand, then a permit may be issued for the qualified stand of trees.



2. TREE CANOPY COVER CREDIT FOR SINGLE FAMILY AND DUPLEX USES.

10.135(e) Tree canopy cover credit for single family and duplex uses. To reduce tree replacement requirements, a portion of existing tree canopy coverage over a single family or duplex construction building site must be preserved.

(1) The tree canopy cover goal is **40 percent** of the building site.

(2) Healthy large and medium trees preserved on the building site, including boundary trees, may be included in tree canopy cover calculations. Invasive trees and trees located within 20 feet on center of the nearest overhead public electric line are not included in the calculation.

(3) Each large and medium nursery stock tree planted as landscaping may also qualify as 300 square feet of tree canopy cover. If the tree canopy cover goal is met, additional landscape trees are not required, except that one tree must be provided in the front yard.

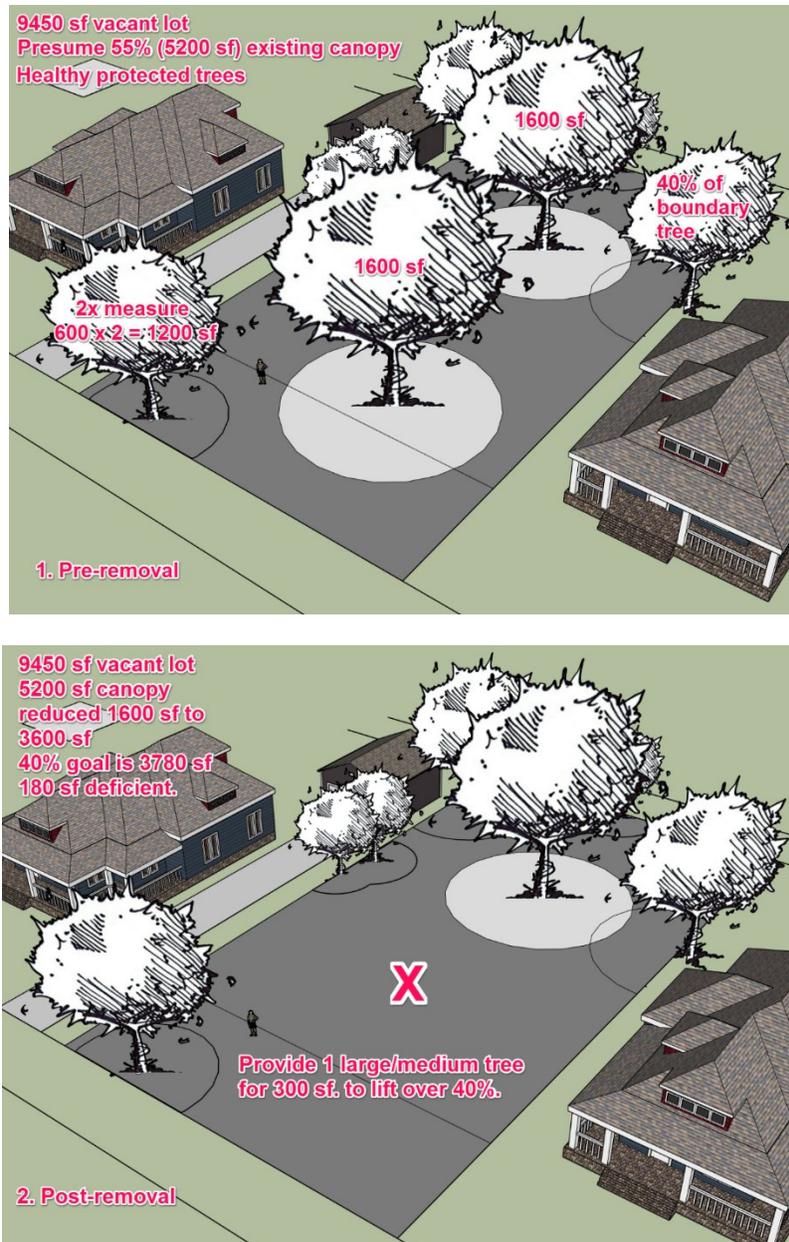
(4) Healthy large and medium trees preserved in the required front yard setback may qualify for double the total square footage of preserved tree canopy coverage.

(5) Boundary trees located on adjacent private property must be protected to the drip line according to the **tree protection plan**.

(6) The tree canopy cover must be measured by a forest stand delineation, verified and approved by the building official. The forest stand delineation must be provided by a **consulting arborist**.

The tree canopy coverage for single-family and duplex uses is an option provided for all single-family and duplex construction lots. If the site can provide a suitable amount of conserved healthy tree canopy over the property, it may qualify for this mitigation deduction. Tree conservation is the basis for this process to work.

The canopy goal coverage is 40%, which includes all trees on the property with exceptions for invasive plants and those growing (at the base) within 20' of public overhead electric lines. The canopy of trees growing over property lines from adjacent properties may be counted if the tree's root system is also being protected from construction damages. Refer to Section 51A-10.136(b).

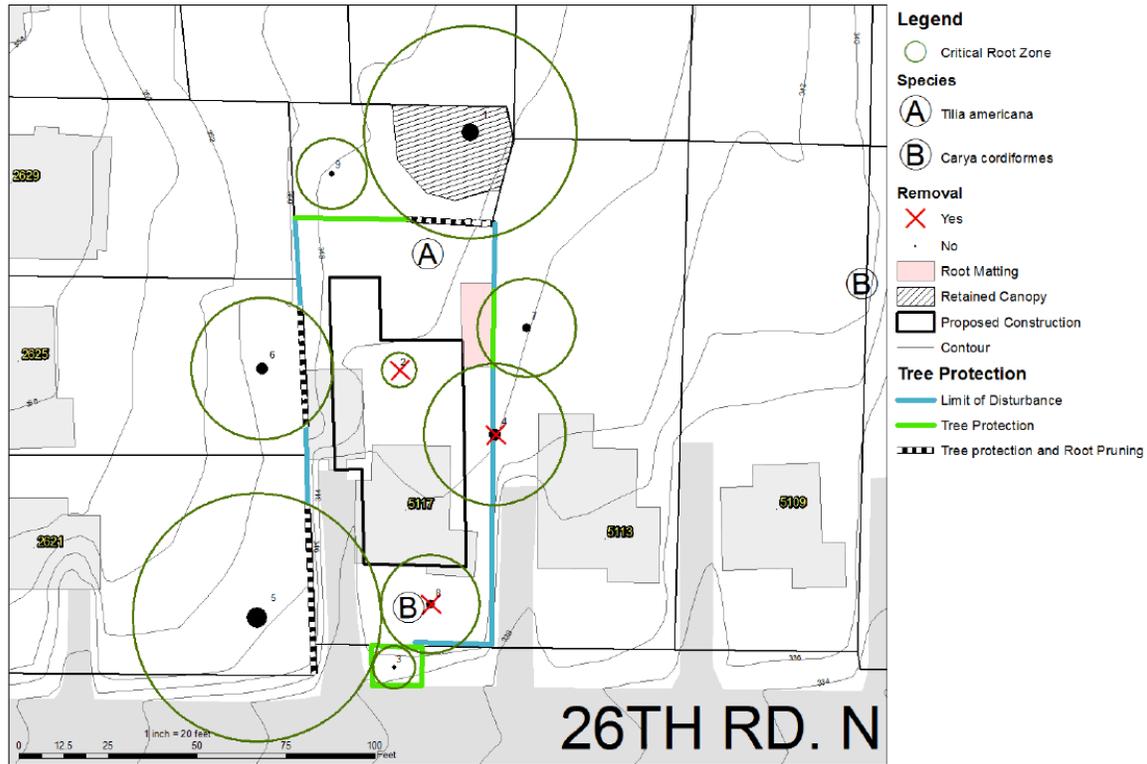


11. The removal of a center tree could be mitigated by the retention of front and rear yard trees.

The owner may provide a site plan of the property with a complete tree survey.

Apply tree canopy coverage distances to the survey by representing the edge of the crown over the property on the drawing, including the canopies of boundary trees which may be off the property or in the right-of-way.

Sample Tree Preservation Plan



12. Measure with top-down and ground-up techniques to verify the tree canopy coverage on the lot. An arborist assessment of the trees should also be made.

Calculate the tree canopy coverage of the property except for the removed trees.

Compare the existing tree canopy at the time of permit to the canopy goal of 40%.

Determine the replacement reduction by the percentage difference of the existing canopy to the 40% canopy goal.

If the measured and credited tree canopy coverage for the lot is 32% (goal being 40%), and the tree replacement due is 40", an 80% reduction is provided and the replacement due is 8 inches.

3. Tree canopy cover assessment of development impact areas in conjunction with sustainable development incentives.

See **Appendix F**.

4. Tree canopy cover assessment on properties five acres or larger with institutional and community service uses or recreation uses

*when the measured tree canopy coverage is the baseline for determining the number of trees required for replacement when using the canopy cover replacement calculation for legacy trees in Section **51A-10.134(c)(7)**.*

(7) Additional requirements for forest stand delineation for properties five acres or greater with institutional uses or recreational uses. When an FSD under Section 51A-10.132(b)(5)(D) is used to assess tree canopy coverage:

(A) the tree removal property must maintain or increase the tree canopy coverage for the property recorded in the most recent FSD; and

(B) significant trees that are included in the FSD tree canopy coverage must be replaced according to the diameter standards for significant trees in this article.

(C) A replacement tree that dies within five years of the date it was planted must be replaced by another replacement tree that complies with this section.

The FSD in this process is mainly for calculating the existing and post-construction tree canopy coverage for a large campus, or golf course, or other institution, undergoing a large-scale revision of the use and use of the trees that interact with that use on the property. It is an option to the other forms of mitigation provided under Article X.

If the owner chooses this option, then the FSD must be completed before any disturbance resulting in the removal of trees on the property.

The initial measured tree canopy coverage is the baseline for determining the number of trees required for replacement when introducing the canopy cover replacement calculation for legacy trees (as found in SDI). At the conclusion of the project, the

property must maintain the balance of, or plant an increase of, the tree canopy coverage for property recorded in the most recent FSD.

As example, if a golf course was evaluated for tree canopy coverage from data provided in February, 2016, this information may be used to establish the baseline measurement of tree canopy coverage for comparison. In our case, we will say it's an old course with 33% tree canopy coverage from existing trees.

In the plans for redesign of the golf course, the design team determines there are certain large trees that must be removed to meet the objectives for the club. They use the initial site data to calculate the expected reduction of tree canopy as a result of the future site amendments. Due to the expected changes, our course is reducing the tree canopy coverage by 2.4%.

Being that this is a golf course with many broad landscape areas, and well-maintained site conditions, the canopy reforestation is made up primarily by new legacy trees. This will require fewer trees to attain the initial baseline tree canopy cover than using non-legacy trees only.

- 33% canopy is reduced by 2.4% with the new project.
- The golf course must plant back 2.4% or greater restored canopy by projected calculation of combined existing trees, new legacy trees, and other new nursery stock trees.
- If 2.4% reduction is 15,000 square feet of tree canopy, they must plant back 15,000 square feet of new tree canopy, which is the equivalent of 12.5 planted legacy trees.
- The trees may be placed in appropriate locations throughout the large site which meets the demands for a legacy tree.

5. Forest analysis for baseline documentation to create a conservation easement.

The conservation easement baseline documentation requires detailed information describing the property's physical and biological conditions and its conservation values. Items to be considered include the health and condition of trees and other vegetation, the suitability for wildlife habitat, and other unique features worthy of retention and preservation.

The FSD is used to define upland and floodplain areas on the property as well as distinct stands of trees.

For the purpose of mitigation, the easement must be at least 25% of the size of the development impact area on the tree removal property.

6. Tree canopy cover assessment where trees are removed without authorization.

Tree replacement is required for trees removed without building official authorization. The City of Dallas will require a FSD map of existing conditions at the time of the report of removed trees.

If the owner does not provide the required information, the building official may use aerial imagery from reliable sources and create a field assessment report. The calculations for assessing the removed tree canopy cover, as determined by the building official, shall be used to determine the amount of tree replacement (in diameter inches) required for the property. This is provided to the owner through a notice of violation.

(1) AGE CLASS means a distinct group of trees originating from a single natural event or regeneration activity (i.e., a 10-year age class), as used in inventory management.

(58) STAND means a group of trees or other growth occupying a specific area that is sufficiently similar in species composition, size, age, arrangement, and condition, to be distinguishable from adjacent forest.

(61) TREE CANOPY COVER means the amount of ground area directly beneath a tree's crown to the drip line or the combined crowns of a stand of trees, measured in square feet.

(63) TREE SURVEY means a report that meets all of the requirements for a tree survey in Section 51A-10.132.